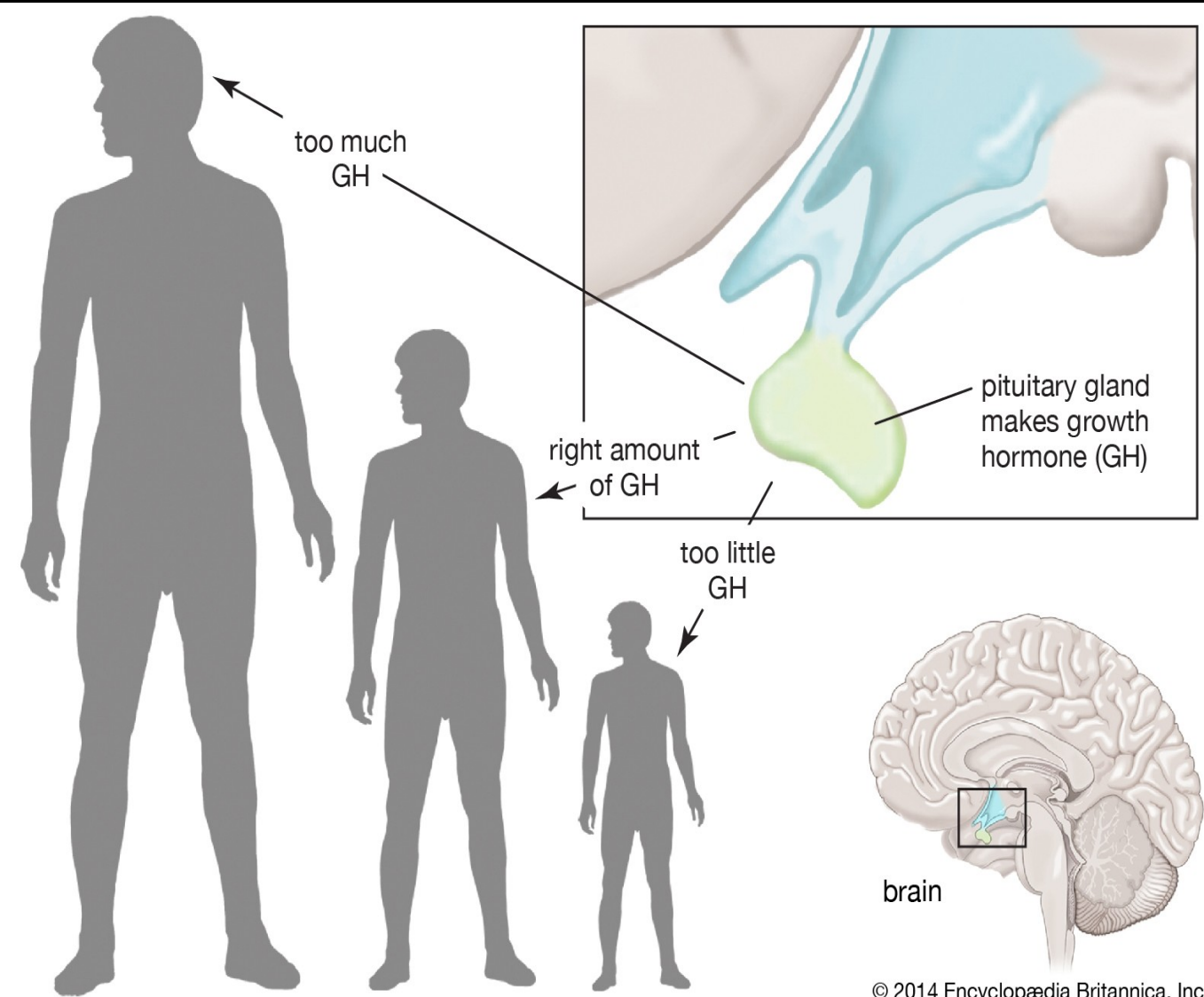




Armed Forces College of Medicine

AFCM

Physiology of The Endocrine System



Growth Hormone

By

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Associate Professor of Physiology



Endocrine Physiology

Lecture 3: Growth Hormone

INTENDED LEARNING OBJECTIVES (ILO)



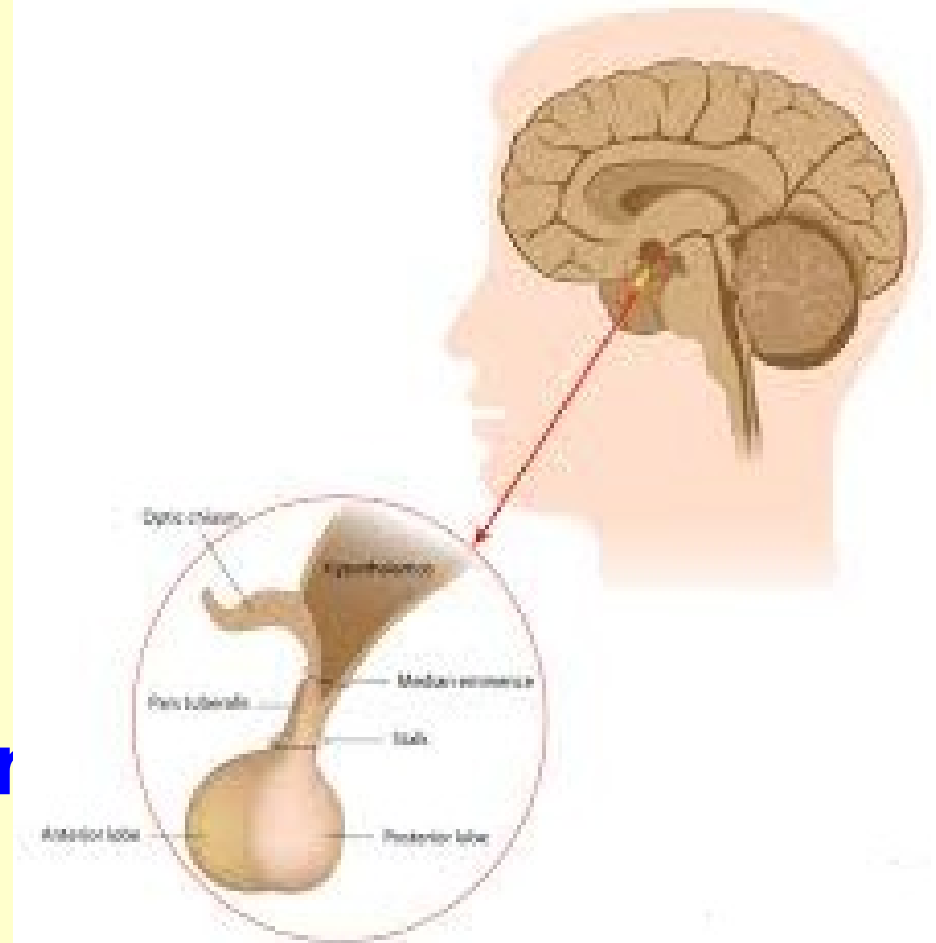
By the end of this lecture the student will be able to:

1. List the hormones that affect growth.
2. Summarize the functions of growth hormone.
3. Describe the role of somatomedin.
4. Summarize growth hormone regulation.
5. List the functions of GHRF and GHIF.
6. Differentiate between abnormal growth hormone secretion before and after puberty.

Introduction



- + **Site of release**
- + **Actions**
- + **Control of secretion**
- + **Abnormalities of secretion**

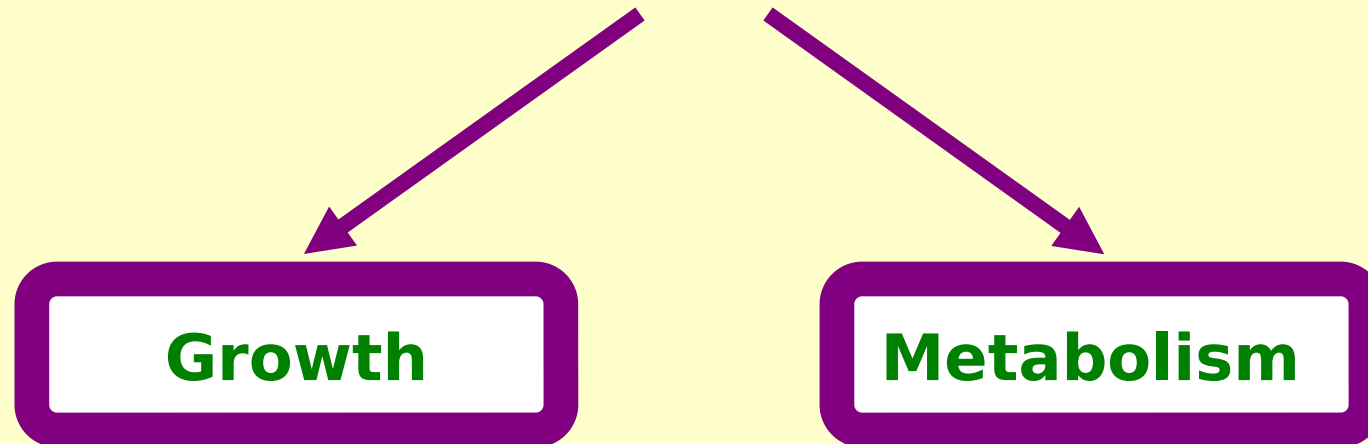


Growth Hormone



- ✚ Secreted by somatotropes
- ✚ It is a protein hormone (191 a.a)
- ✚ Acts through membrane receptors (Tyrosine kinase receptor)

Physiological Effects



I) Growth Effects



- GH exerts its effects on all cells of the body
- Both Skeleton & Soft tissues
- It promotes increase in size (Hypertrophy) & number (Hyperplasia)
- Through favoring protein synthesis
- The general effects are:
 - 1- Increases amino acid uptake
 - 2- Increases protein synthesis
 - 3- Increases DNS & RNA synthesis

I) Growth Effects



Effect on Bone & Cartilage

- Increased bone growth (linear + thickness)
- Indirect effect
- By increase synthesis of somatomedins from liver

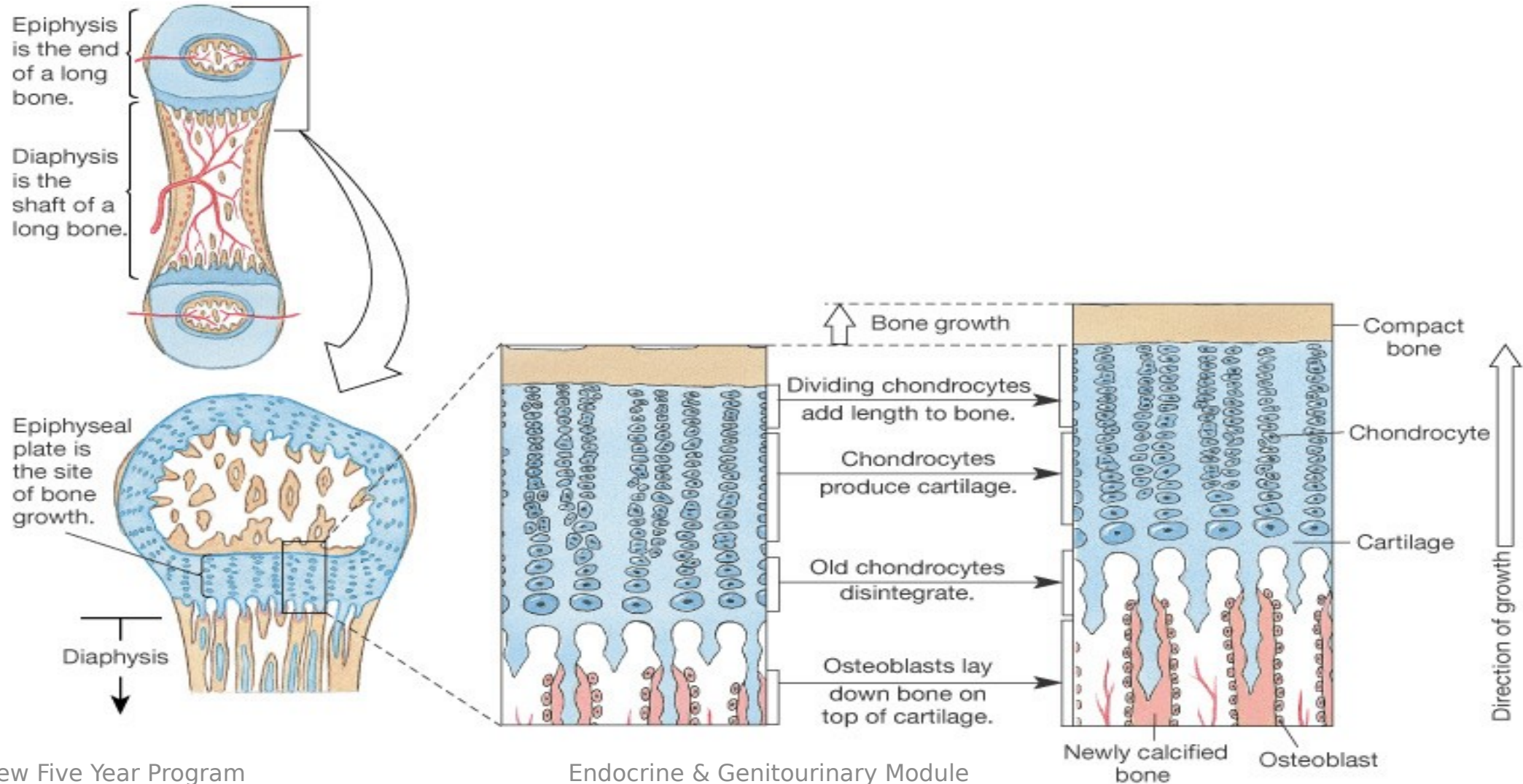
I) Growth Effects



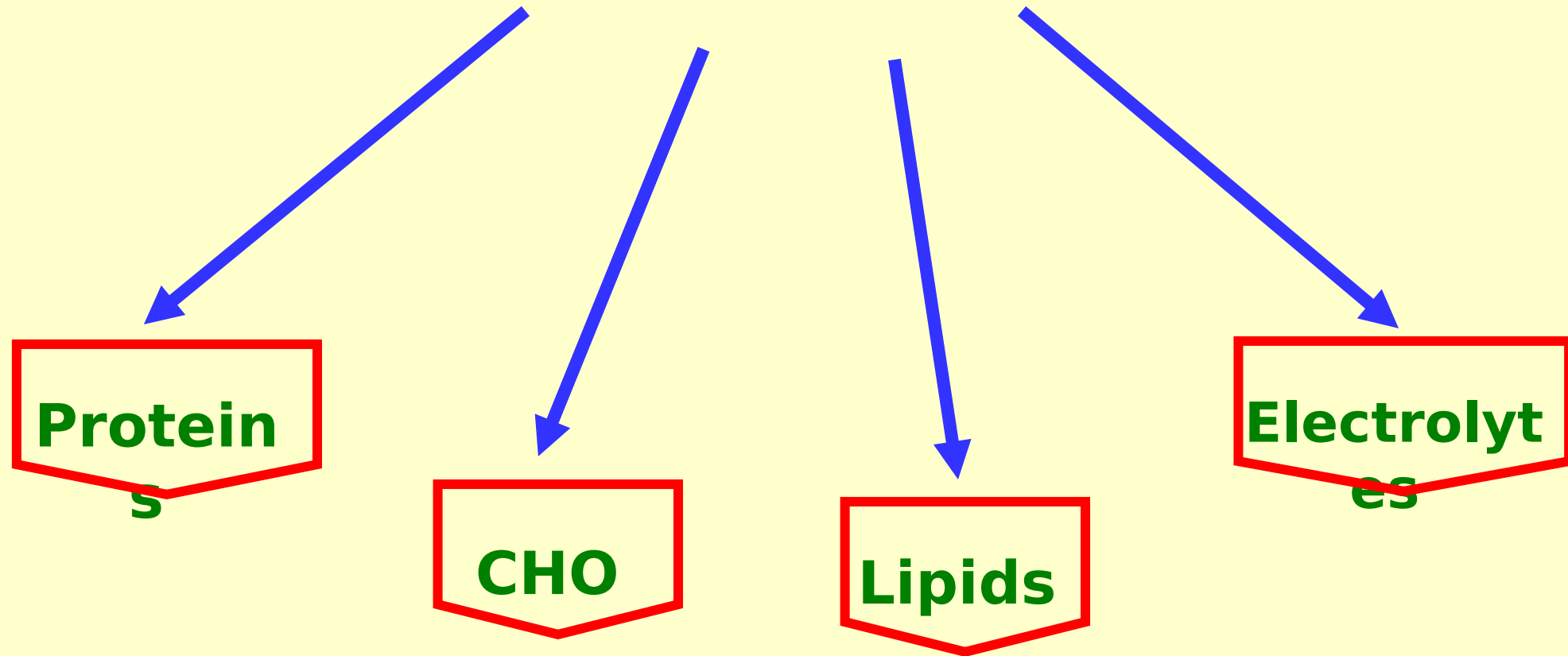
Somatomedins

- It is a protein synthesized in the liver
- They are 2 types
- They called also Insulin-like growth factors (IGFs)
- GH acts through somatomedin C = IGF-1
- They lead to:
 - 1- Growth of epiphyseal cartilage
 - 2- Deposition of condrotin sulfate in epiphyseal plate
 - 3- Increases collagen synthesis
 - 4- Increases sulfur uptake
 - 5- Increases Ca^{+2} & PO_4^{-3} in bones
 - 6- Increases osteoblastic activity

Bone Growth



II) Metabolic Effects



A) Protein Metabolism



- ***Increases*** uptake of A.A.
- ***Stimulation*** protein synthesis
- ***Inhibits*** protein catabolism
- ***Cause +ve nitrogen balance***

Net effect:

□ **Anabolism**

B) CHO Metabolism



- **Increases** hepatic glucose output
- **Decreases** glucose uptake & utilization by adipose tissue & muscles (= **anti-insulin effect**) □??
- Net effect:
 - □ Blood glucose level (**Hyperglycemia**)
 - Hyperglycemia + Insulin resistance □□ **Diabetes**

C) Lipid Metabolism



- ***Stimulation*** of lipolysis (**Hormone sensitive lipase**)
- ***Stimulation*** FA oxidation (**Ketogenesis**)

Net effect:

□ □ **Blood FFA + KB**

D) Electrolytes

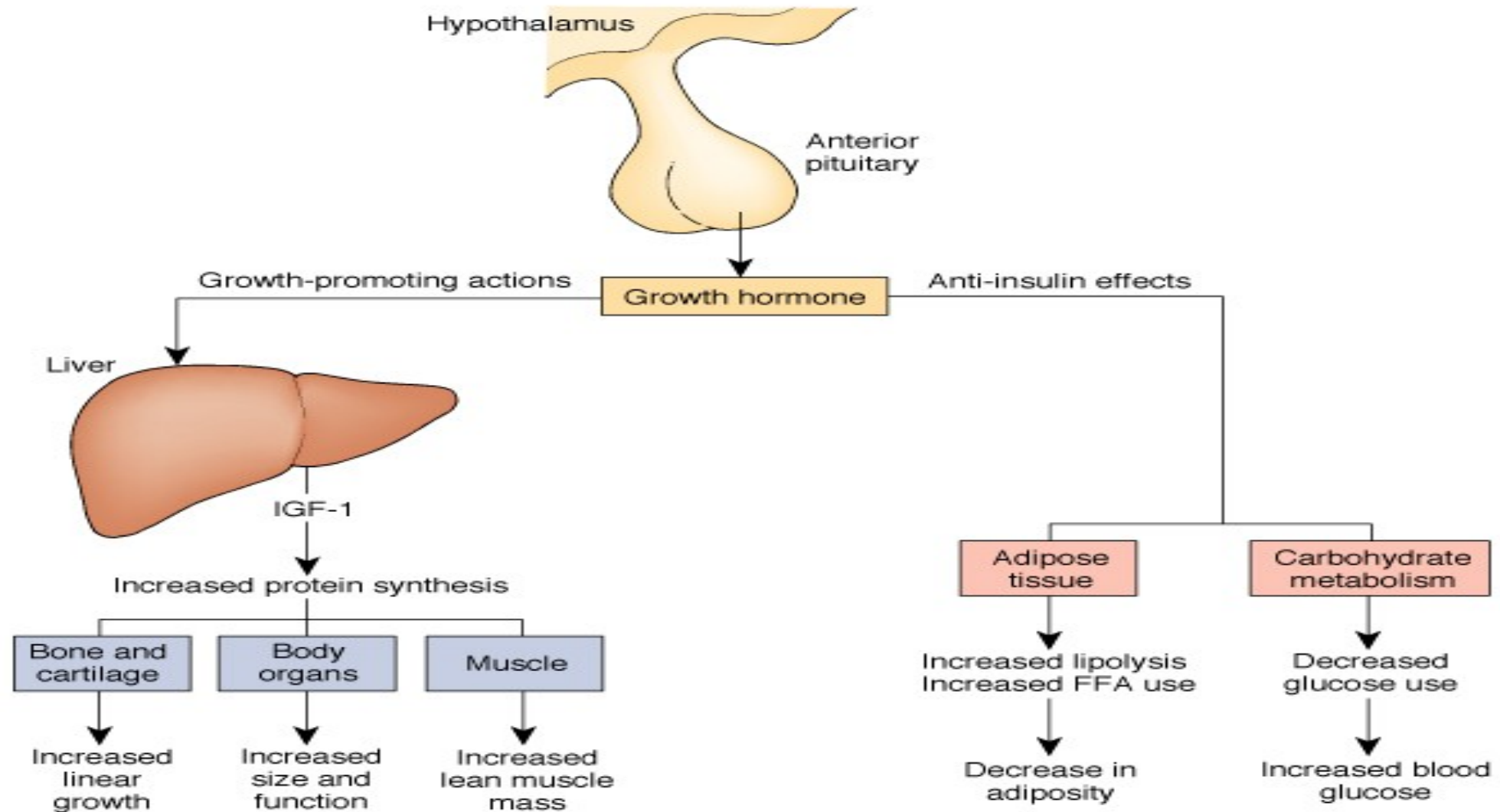


- ***Increases*** Ca^{+2} absorption from GIT
- ***Increases*** PO_4^{-3} plasma level
- ***Decreases*** Na^{+} & K^{+} excretion by the kidney

Net effect:

- □ **ECF volume**

Growth Hormone



Control of Secretion



Hypothalamic Control



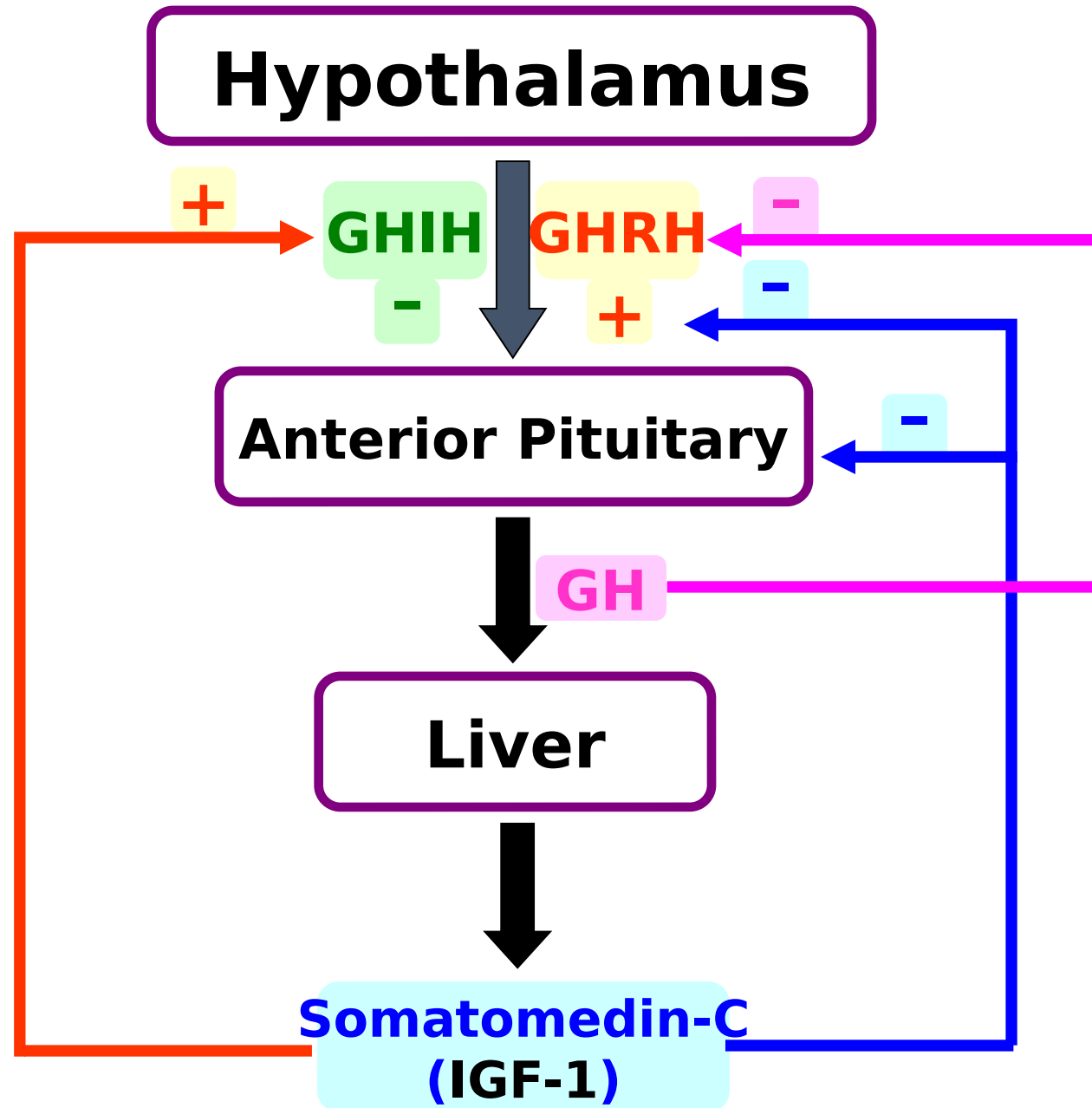
Negative Feed Back

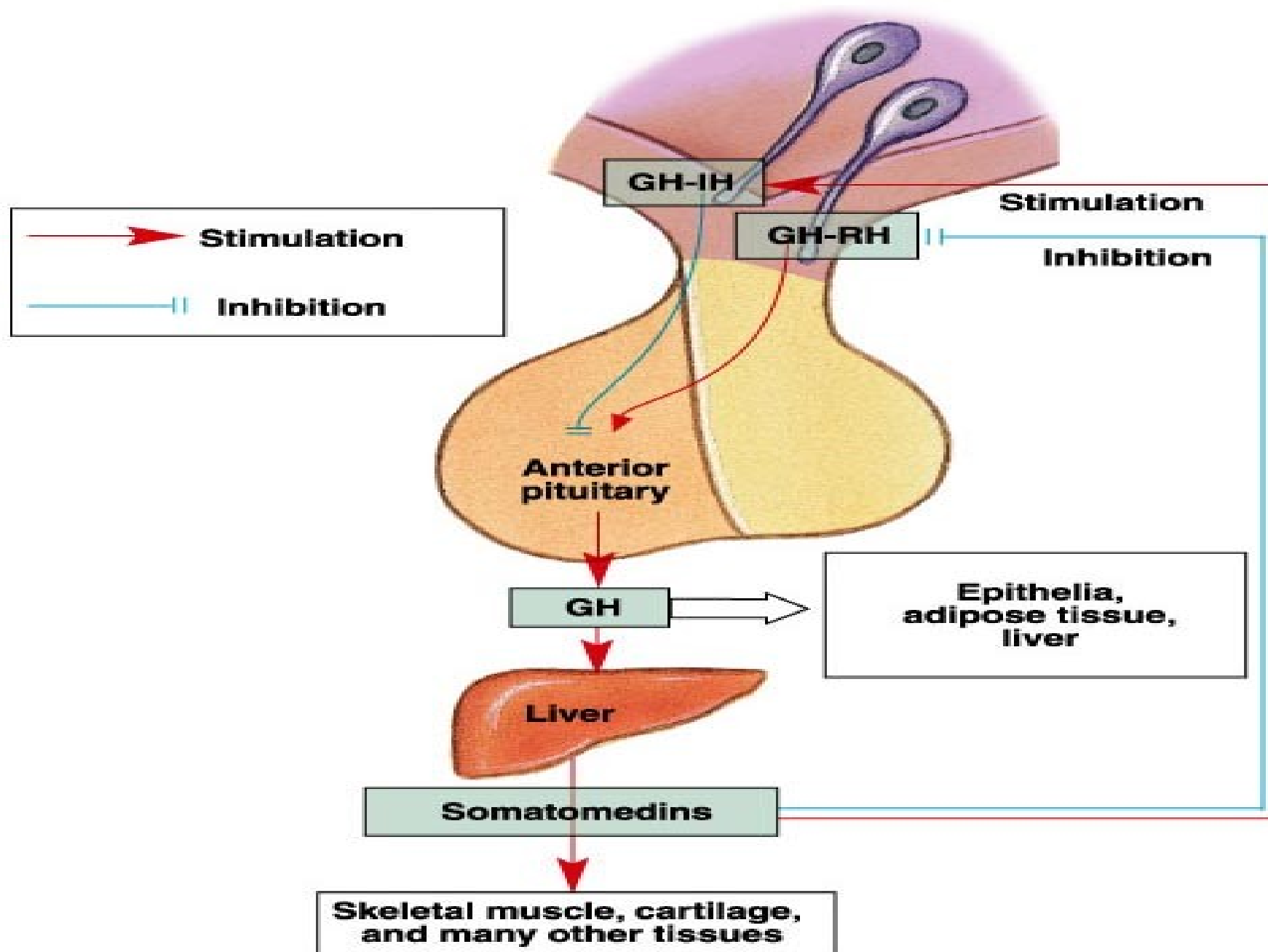


Diurnal Variation

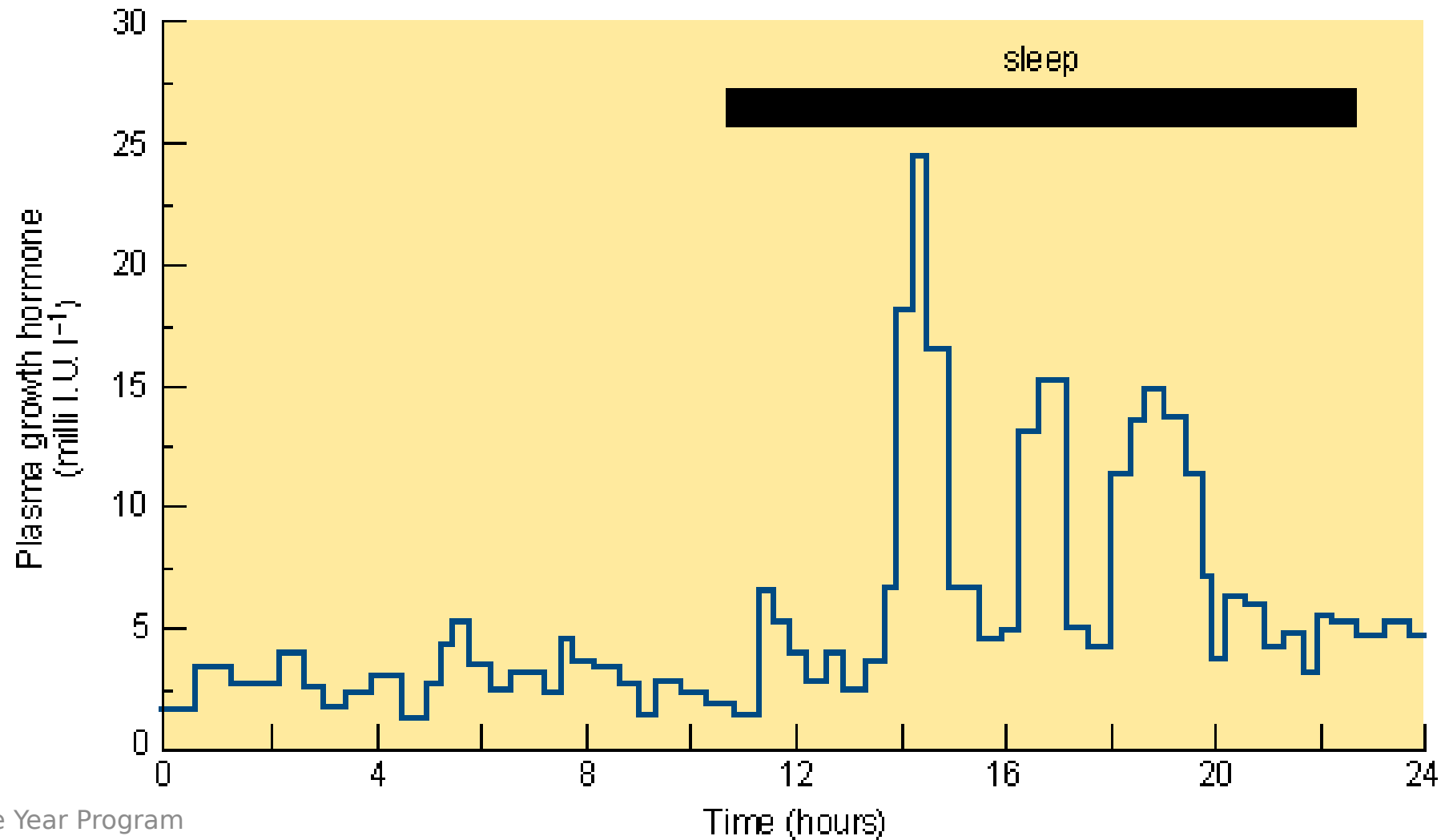


Others





Diurnal Variation

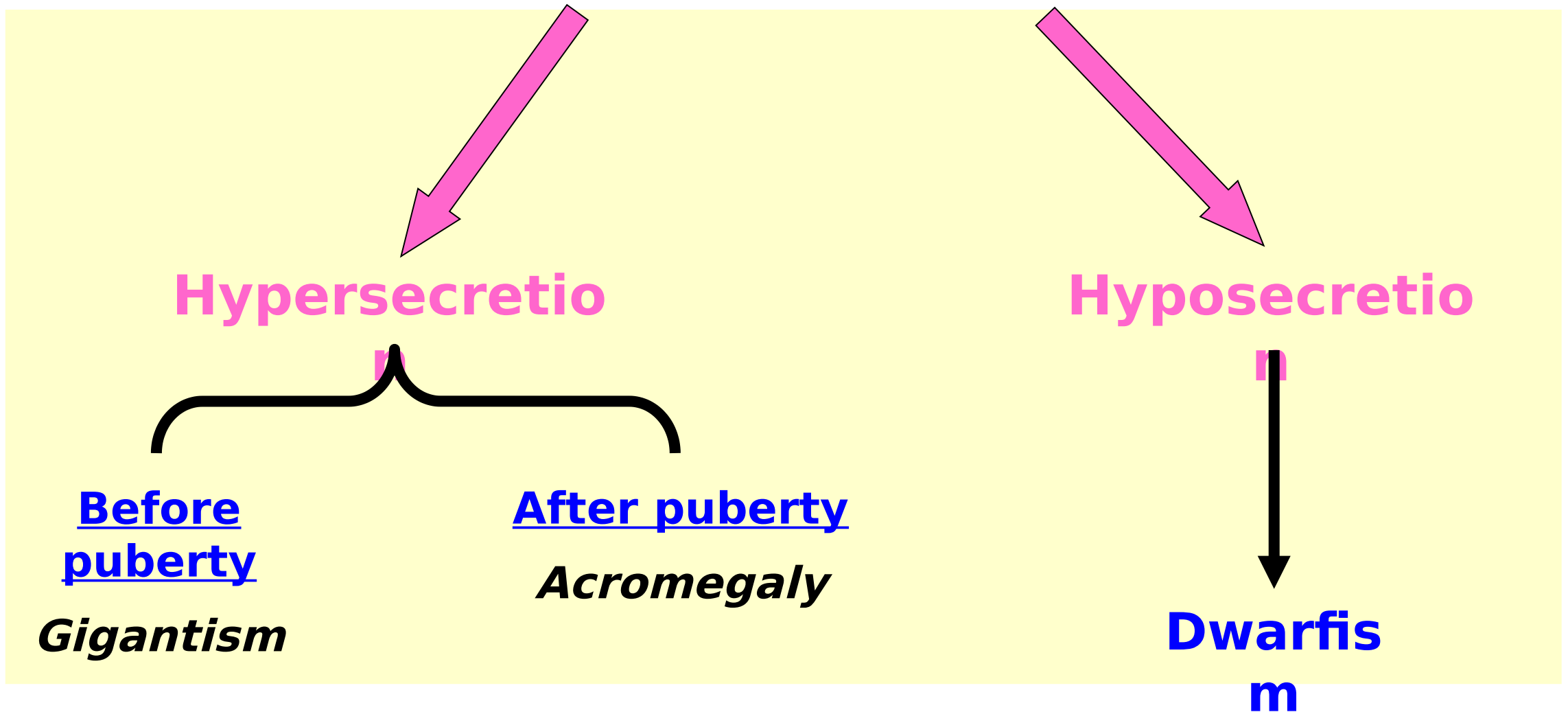


Factors/Conditions that Control GH Secretion



Decrease GH Secretion	Increase GH Secretion
<ul style="list-style-type: none"> - Increased blood glucose - Increased blood FFA - Obesity - Cortisol 	<ul style="list-style-type: none"> - Decreased blood glucose - Decreased blood FFA - Increased blood AA (after protein meal) - Starvation, Fasting - Exercise
<ul style="list-style-type: none"> - GHIH (Somatostatin) - GH - IGF-1 - Aging 	<ul style="list-style-type: none"> - GHRH - Going to sleep

Abnormalities of GH Secretion



Gigantism



Cause:

- Excess GH secretion before puberty = before union of epiphysis

Clinical Picture:

- a- **Overgrowth of all bones** □ Symmetrical enlargement
□ □ Height (> 2m) + □ Weight
- b- **Overgrowth of soft tissues** □ Enlargement of internal organs
□ Muscular strength □ Superman ??
- c- **Hyperglycaemia** □ Diabetes Mellitus
- d- **Hypogonadism** (??)
- e- **Galactorrhea** (??)

Gigantism



New Five Year Program



Endocrine & Genitourinary Module

Gigantism



New Five Year Program

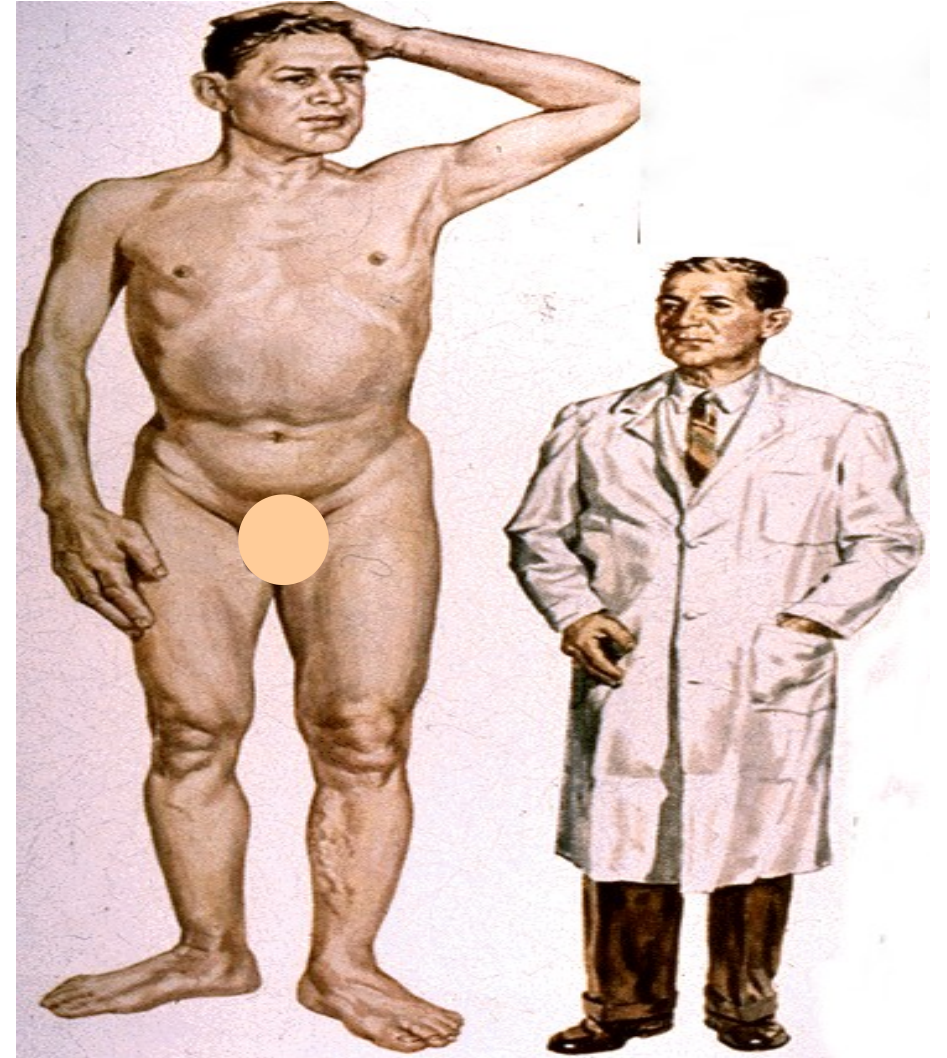


Endocrine & Genitourinary Module

Gigantism



New Five Year Program



Endocrine & Genitourinary Module

Acromegaly



Cause:

- Excess GH secretion in adult after union of epiphysis

Clinical Picture:

1) Bones:

Akron = extremity

Mega = large

- **No** growth of long bones □ No □ in length
- Overgrowth of acral bones (= **Terminal parts, Short bones**)
- Overgrowth of membranous bones (= **Skull, Vertebrae, Mandible**)
- Overgrowth of cartilage(= **Nose, Ears**)

Acromegaly



2) Soft tissues:

- Overgrowth of all soft tissues (= **Lips, Tongue**)
- Overgrowth of all internal organs
- Overgrowth of skin, connective tissues, glands, hairs (= **Scalp**)
- Overgrowth of muscles(**Strength**)
- Facial features
- Hypertrophy of larynx □ Deep, husky voice

Acromegaly



3) Endocrinal disturbances:

- Diabetes Mellitus (25 % , ??)
- Hypogonadism (??)
- Gynaecomastia + Galactorrhea (4 % , ??)

4) Visual disturbances

5) Peripheral nerve disorders (??)

6) Hypertension (??)

Acromegaly



Sausage-like
(broad fingers)

**Thick, wrinkled
skin**



Spade hand

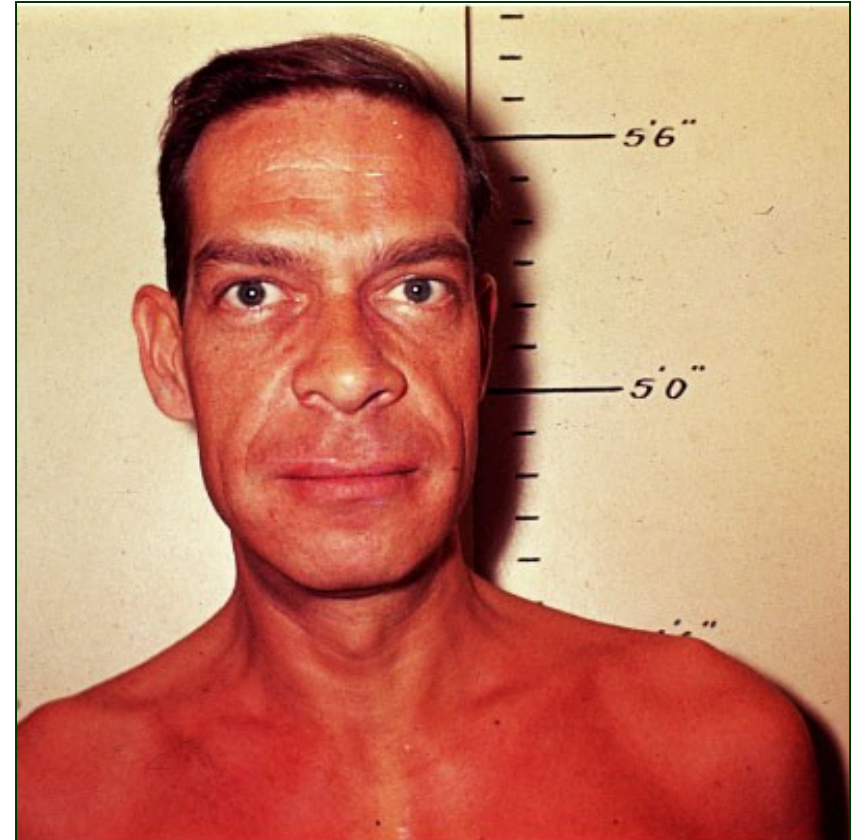
□ Hair

Acromegaly



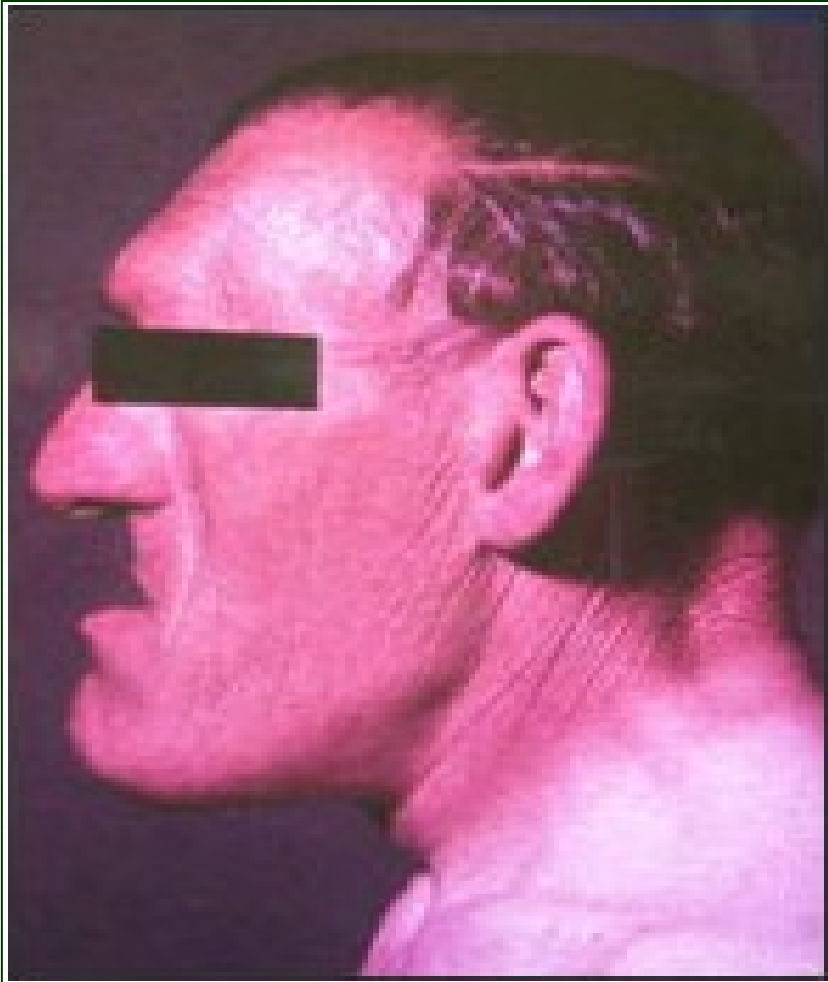
**Coarse features
Ape-like**

**Box-shaped
skull
Bull dog-
scalp**

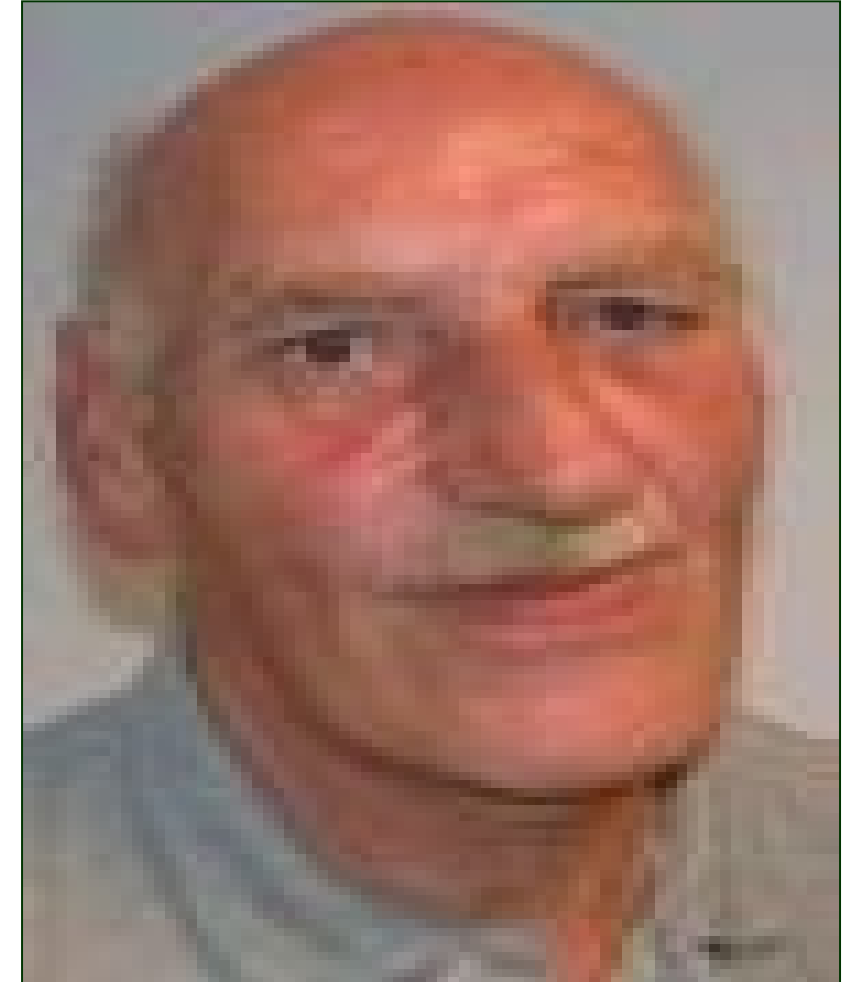


**Prominent
supra-orbital
ridges**

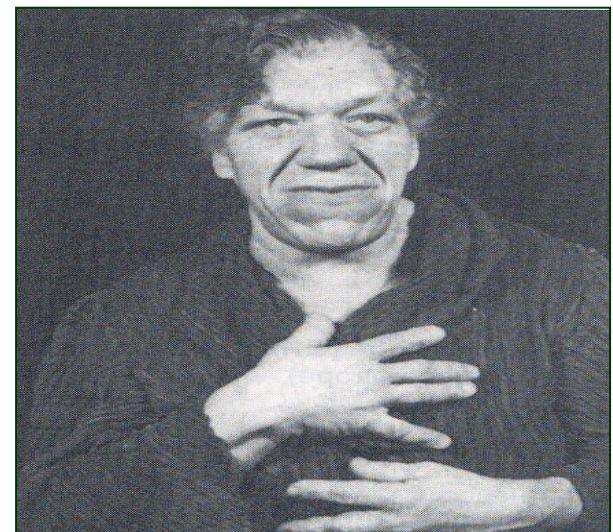
Acromegaly



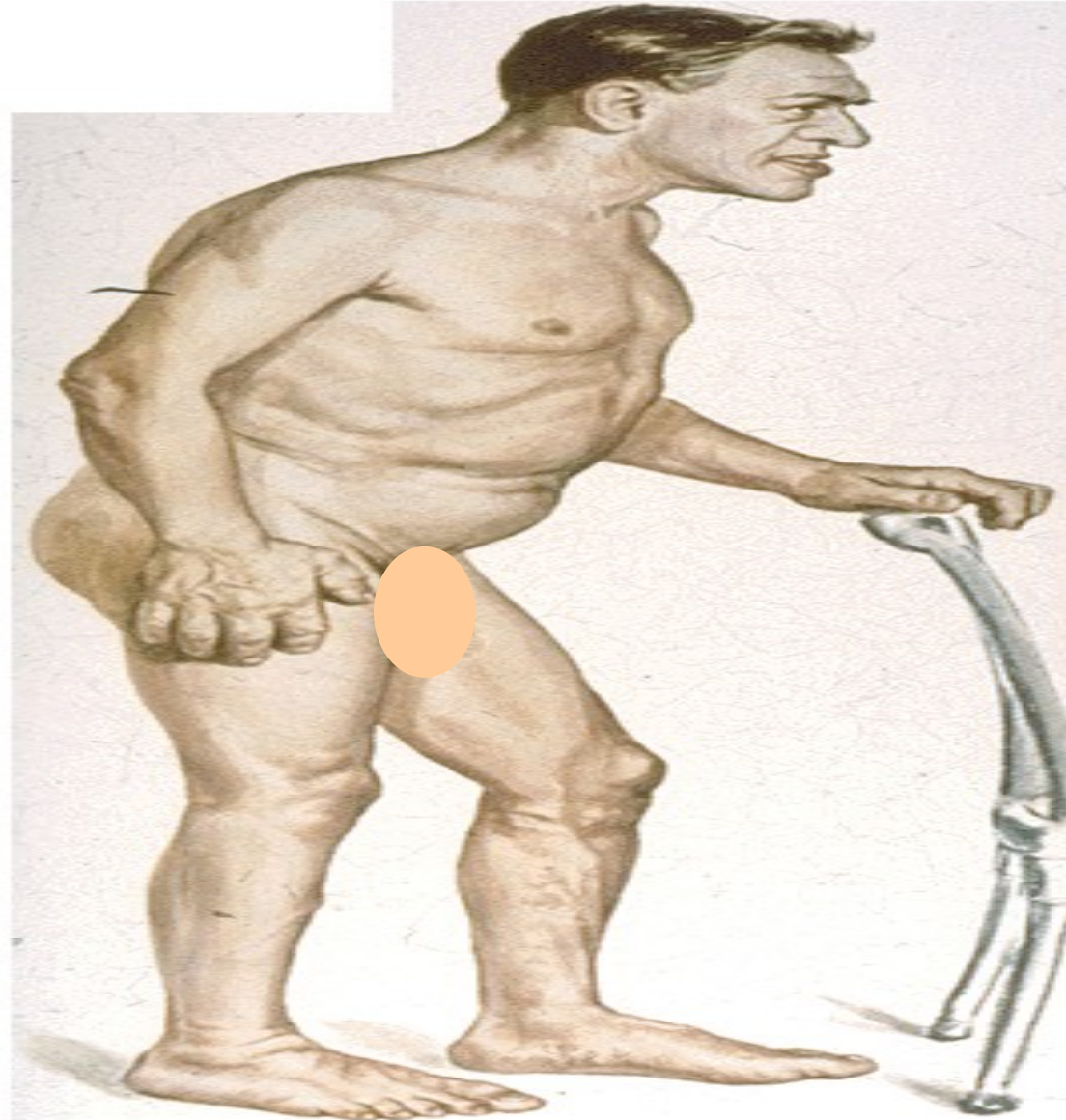
**Prognathi
sm**



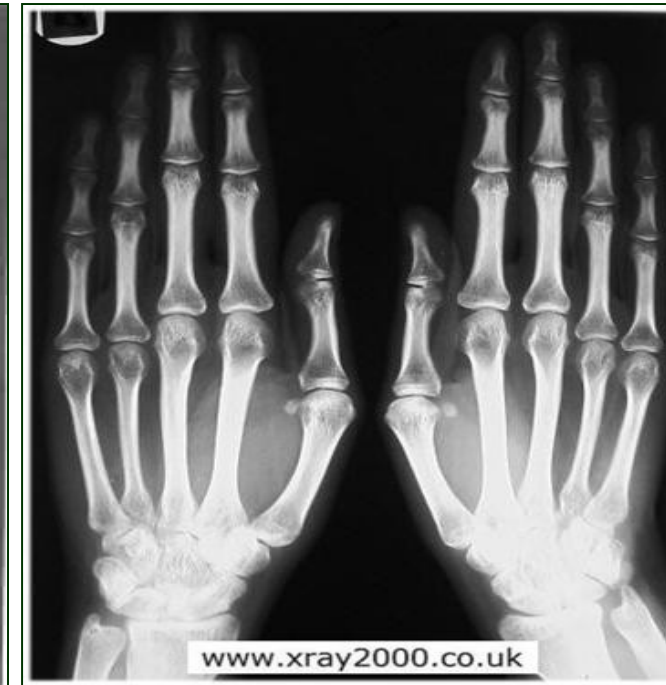
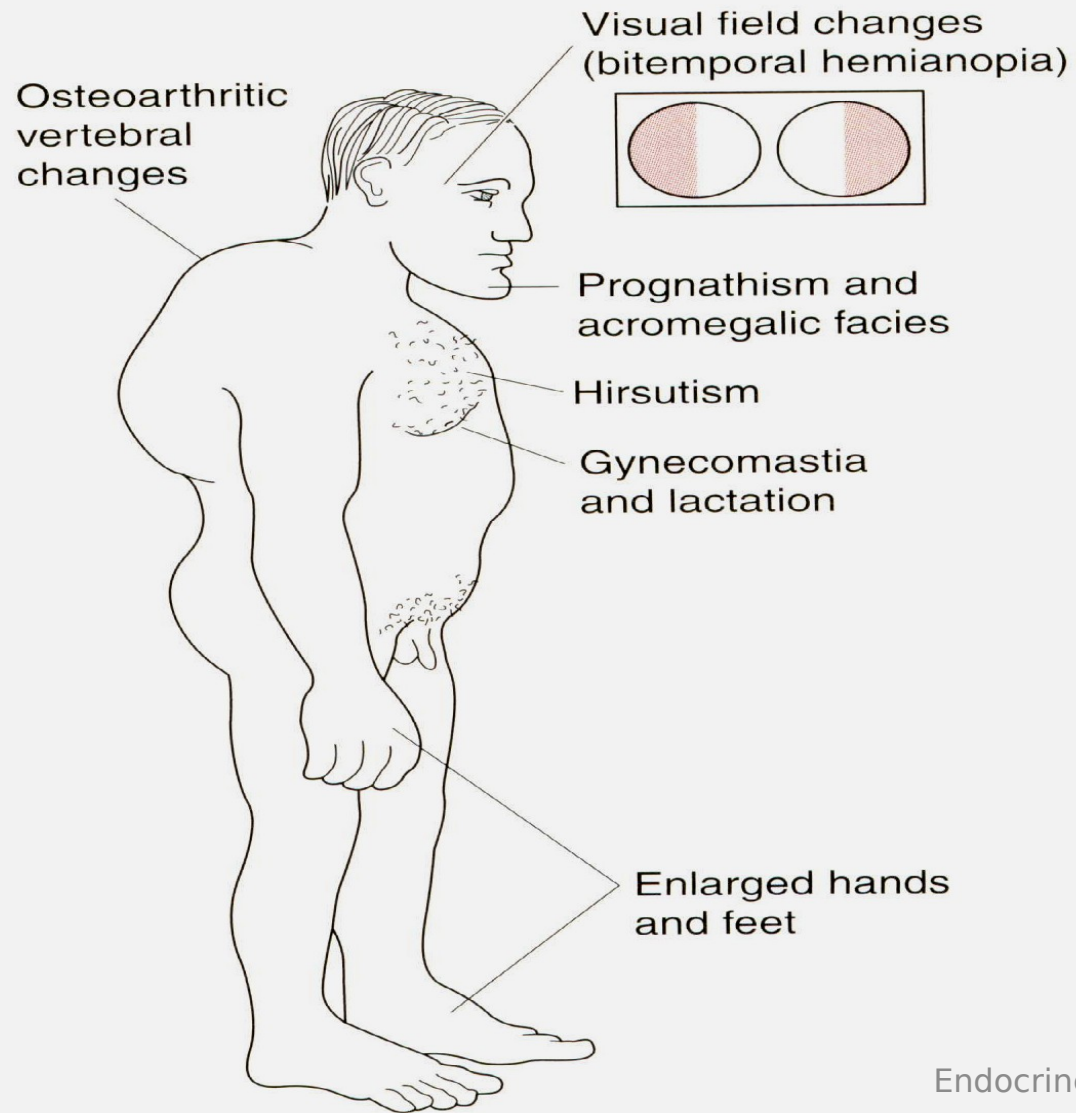
Acromegaly



Acromegaly



Acromegaly



Growth Hormone Hyper secretion

Before puberty

Gigantism

↑ GH before closure
of epiphysis

↑ Linear growth
↑ Soft tissue
Rapid growth

Body parts
are
proportionate

Hyperglycemia

After Puberty

Acromegaly

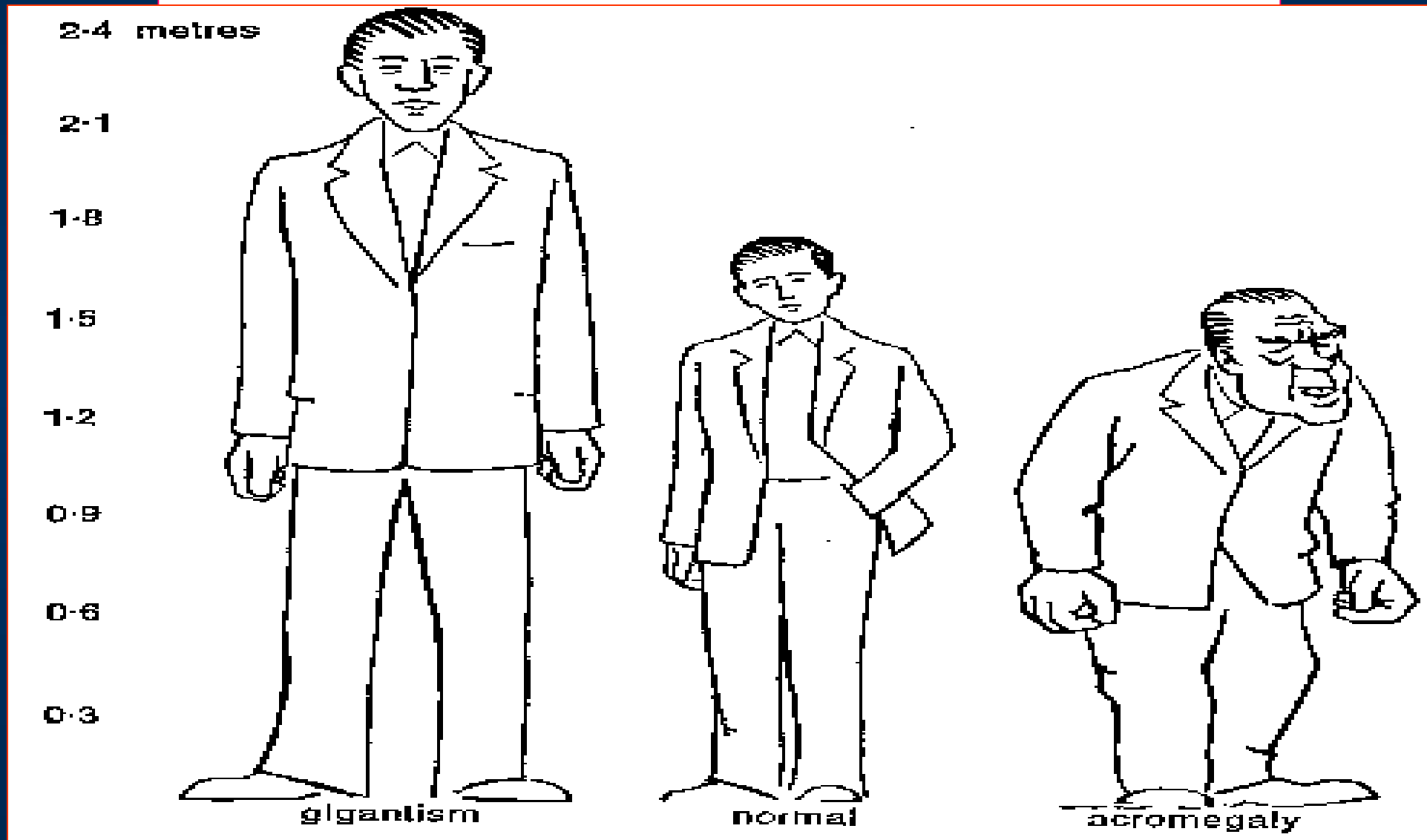
↑ GH after closure
of epiphysis

No linear growth

**Disfigured person
Ape-like**

Hyperglycemia

Effect of GH



□ GH Secretion



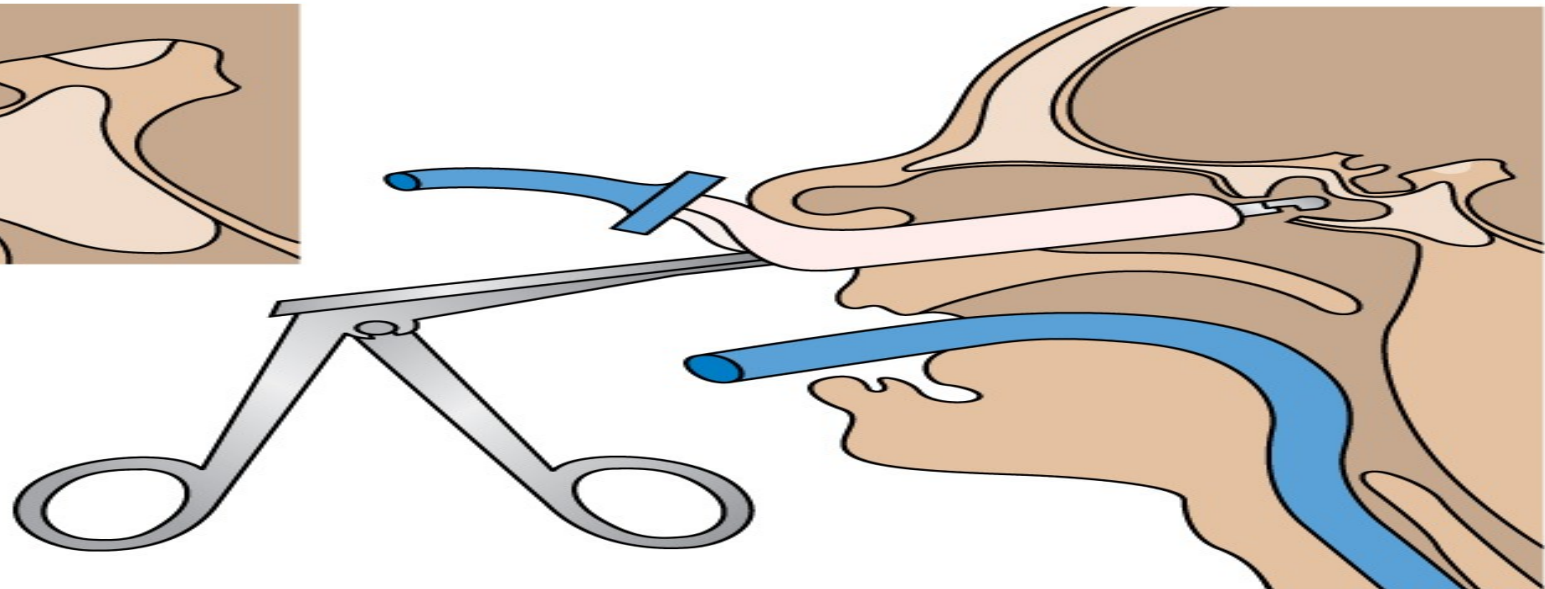
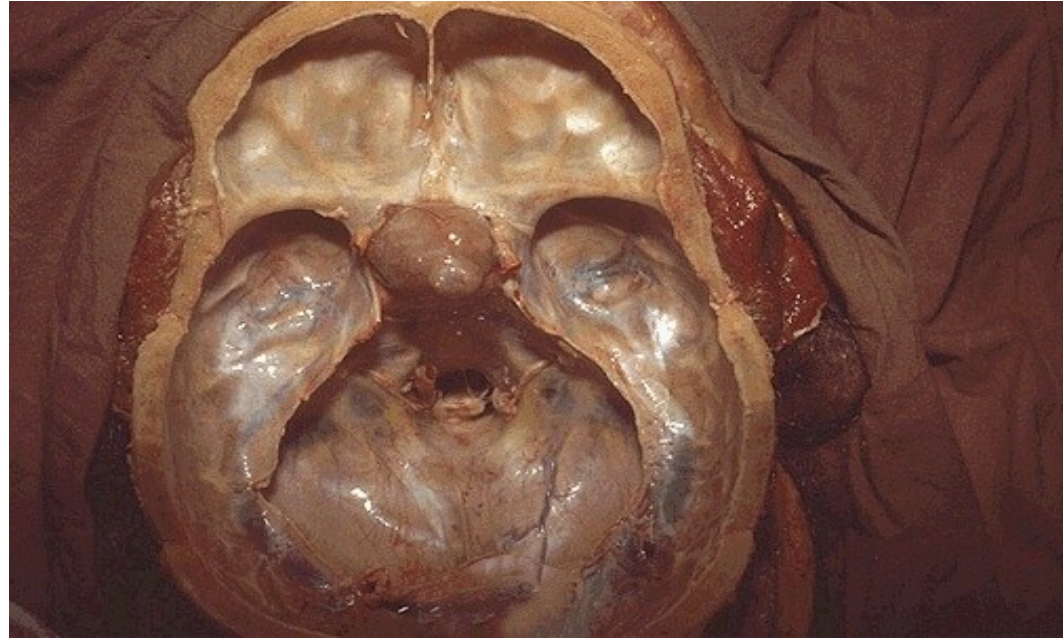
Diagnosis:

- a) Clinical Picture**
symptoms + signs
- b) Hormonal level**
 - GH
- a) Radiological examination**
 - CAT scan
 - MRI

Treatment:

- Surgical removal
- Hormone replacement therapy





Pituitary Dwarfism



Definition:

- Decrease GH secretion before puberty

Causes :

- 1- Hypothalamic disorder
- 2- Pituitary disorder
- 3- Inherent GH deficiency
- 4- Secretion of inactive GH
- 5- Lack of somatomedins
- 6- Lack of end organ response (**Receptor defect**)

Clinical Picture:

- a- **Growth** □ - Symmetrical retardation of growth - Height 100 - 120 cm
- b- **Mentality** □ - Normal
- c- **Sexuality** □ - Normal

Pituitary Dwarfism



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Endocrine & Genitourinary Module

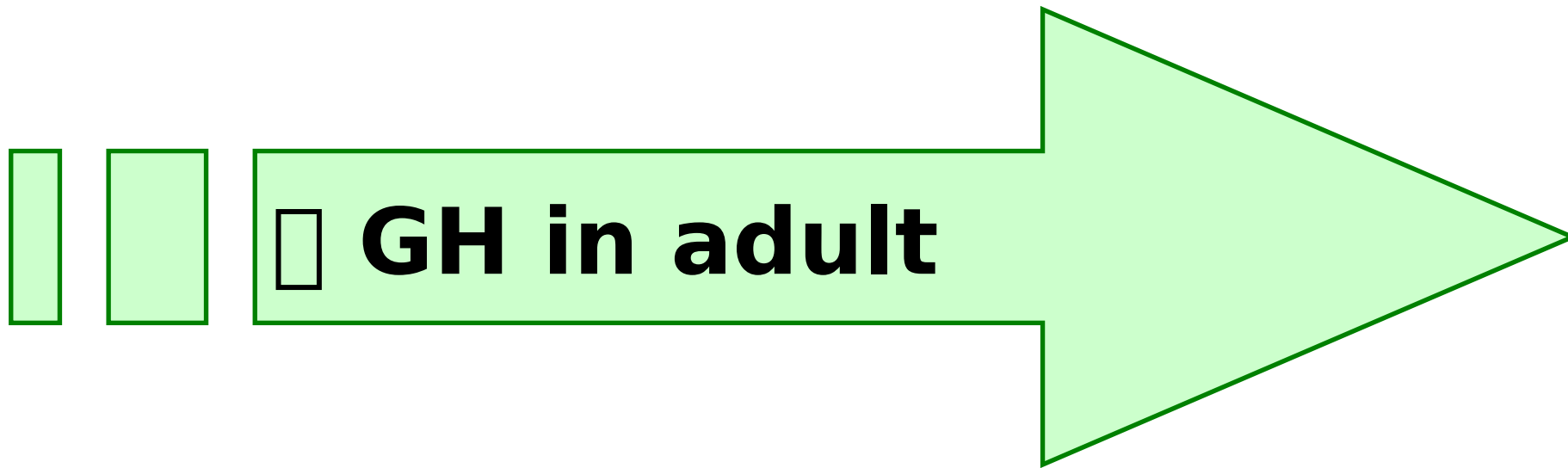
Pituitary Dwarfism



Pituitary Infantilism



- **Pituitary Dwarfism + Hypogonadism**
- **Due to deficiency of:**
 - a) GH**
 - b) Gonadotropins**



□□□ NO manifestations

- □ Muscle mass +
- □ Muscle strength & exercise performance
- □ Bone density
- Hypoglycemia
- Progeria (rapid & premature aging)

Growth Hormone Deficiency

During adult life

**Minimal
effects**

**Decreased
muscle
strength**

**Decreased
bone
density**

During childhood

**Pituitary
Infantilism**

Dwarfism

**Normal
mentality**

**Failed
sexual
maturity**

**Combined
defect**

**Pituitary
Dwarfism**

Dwarfism

**Normal
mentality**

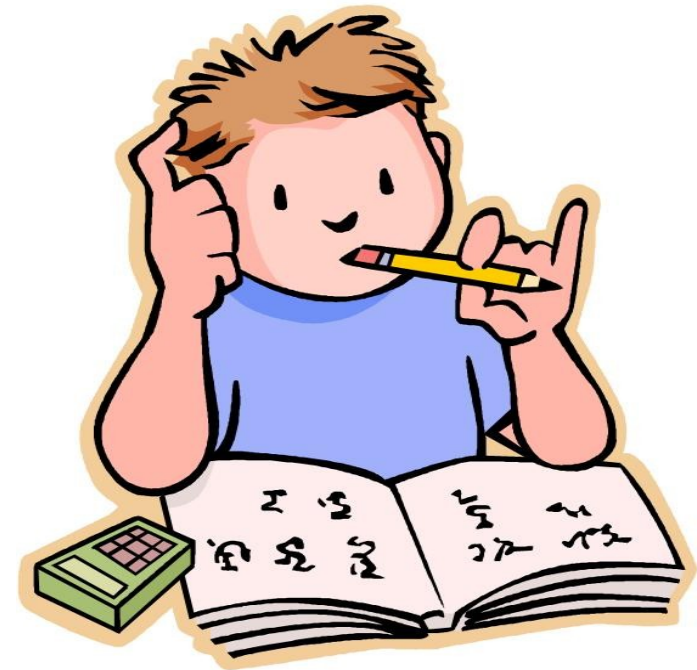
**Normal
sexual
maturity**

Lecture Quiz



Q- Which of the following inhibits growth hormone secretion?

- A. Hypoglycemia.
- B. Exercise.
- C. REM sleep.
- D. Stressful stimuli.



Lecture Quiz



Q- Growth hormone secretion would most likely be suppressed under which of the following conditions?

- A. Acromegaly.
- B. Gigantism.
- C. Panhypopituitarism.
- D. Exercise.

SUGGESTED TEXTBOOKS



1. Guyton and Hall

Text book of Medical Physiology, 13th Edition (2016), Chapter 76 (**Pituitary Hormones and Their Control by the Hypothalamus**)

2. Ganong's

Review of Medical Physiology, 24rd Edition (2012), Chapter 18 (**The Pituitary Gland**)

3. Fox

Human Physiology, 14th Edition (2016), Chapter 11 (**Endocrine Glands: Secretion and Action of Hormones**)

4. Sherwood

Human Physiology .. From Cells to Systems, 9th Edition (2016), Chapter 18 (**Principles of Endocrinology; The Central Endocrine Glands**) pp:

286 - 294



THANK YOU